

METHOD FOR BATCH TESTING RED TART CHERRIES FOR THE PRESENCE OF PIT FRAGMENTS

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ABSTRACT

A previously developed method (Haff and Schatzki 1993) for detecting pits in red tart pitted canned cherries was expanded to detect pit fragments as well. The cherries were pulped in a modified kitchen blender and poured into a slit sieve designed with an adjustable slit width to let the cherry pulp wash through while retaining the pits and fragments. Some further fragmentation of pit fragments occurred during blending (3-5.5%), but can be corrected for. With an optimized slit width of 1.5 mm, 79% of fragments were caught by the sieve and thus detected, independent of fragment length. Passage of fragments followed a binomial distribution. This method, while not an on-line one, uses exceedingly simple and inexpensive equipment and is ideally suited for field testing.

INTRODUCTION

86,000 metric tons of red tart pitted (RTP) cherries are produced every year, which makes them a significant crop in US Agriculture. Ninety eight percent of this crop is processed and sold frozen or canned. The machines that have been developed for pitting the cherries are extremely efficient, missing only 1 pit per 5200 g of cherries overall (Binde *et al.* 1992). Machines cannot remove all the pits because occasionally the plungers used by the pitter miss the pit due to natural variations in cherry size and pit location. In addition, the pitter can occasionally smash the pit, resulting in fragments. These pits and pit fragments can become lodged in the throat of the consumer where they can cause choking or physical harm.

Much research has been done to try to detect and possibly remove as many of the pits and fragments as possible before they reach the consumer, preferably by on-line processing. Much of this work was reviewed by Timm (1991) and

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Haff and Schatzki (1993). Allen *et al.* (1966) and Law (1973) used IR and light scattering to detect pits but these methods were sensitive to fruit orientation. Gillespie *et al.* (1987) used on-line light transmission. The method failed commercially for performance reasons (Brown, as quoted by Timm *et al.* (1991)). A British patent (Anon. 1978) attempted to detect pits by compression as they fell from the pitting machine. A U.S. patent (Ross and Crawford (1979)) took much the same approach except that the pitted cherries themselves were compressed. The success of either is not known. Timm *et al.* (1991) attempted to do much the same, but using a light beam, but they were foiled by cherry debris emanating along with pits. A number of other physical techniques were tried, but all were found unsuccessful at on-line speeds. Zion *et al.* (1997) and Clark *et al.* (1997) used NMR projection and imaging to detect remaining pits. NMR is too expensive for commercial implementation. Peterson (1989) mentions an on-line commercial system which detects pits remaining in RTP cherries on the basis of size and density. It is said to reduce pit frequency from 1 pit/16 kg to 1 pit/57 kg; false positive rates are not given. The detection of pit fragments has not been tested for. Fragments, which are as much of a health threat as whole pits, can easily be missed because of their smaller mass.

The method currently in use for testing for the number of pits in a batch of RTP cherries (common sample size is 567 g or 20 oz.) consists of dumping the cherries onto a tray, mashing them by hand and then feeling around for pits. Since the industry demands a level no higher than 1 pit per 28.3 kg (no standards have been set for fragments), this requires the test of at least 50 batches. While this method is relatively rapid (15-20 s per batch or about 15 min per 28.3 kg), it is labor-intensive and messy, and can easily lead to pits and especially pit fragments being missed and mistaken for lumps of cherry flesh (actual tests of these errors are not available). In 1994, a batch method of detecting whole pits remaining in RTP cherries after processing was reported by Haff and Schatzki (1994). Unlike previous studies which targeted the on-line cherry processing stream, this study focused on batch testing cherries after they had been pitted thus avoiding some of the problems encountered by the on-line approach. The method developed by Haff and Schatzki consisted of slurrying the cherry product [canned cherries, cherries that were frozen in bulk with sugar (five parts cherries, one part sugar, 5-1) and thawed for the test, or individually quick frozen (IQF) individual cherries which were again thawed]. Slurrying was done using a modified kitchen blender and passing the resulting slurry through a slit strainer with a fixed 2.8 mm slit. Better than 99% of the pits were detected with no false positives. These results were so encouraging that the possibility of using this method to detect pit fragments arose and is the focus of this paper.

Pit fragments are difficult if not impossible to detect using the parameters (largely the slit size) of the Haff-Schatzki method because fragments are often thin, flat, and much smaller than pits. As a result they could easily slip through

the slit of the strainer edge-on. It was thought possible that modifying this method would make it sensitive enough to detect fragments. Caution had to be taken because fragments are more delicate than the whole pits. The whole pit consists of the kernel enclosed by the shell and the integral structure protects the rather thin shell. Fragments consist almost entirely of shell material which are easily fragmented further by the blades of a blender. Since larger fragments are of interest, refragmented shell pieces are not representative of the material to be tested.

MATERIALS AND METHODS

Only significant changes from the method developed by Haff and Schatzki (1994) are reported here. Pit fragments were produced from whole RTP pits by allowing the latter to dry. They were then wrapped in cloth and fragmented by breaking with a hammer. It was found that such treatment resulted in fragments similar in shape to those found in actual commercial product (referred here as "natural" fragments). Pits and fragments were dyed so that the presence of natural (undyed) pits and fragments in the cherry stock material could be detected. Before use, fragments were soaked in cherry juice for at least 16 h. Fragments were sorted according to maximum length by individual measurement to within 2 mm. Only fragments longer than 5 mm were used, on the assumption that smaller fragments would pass harmlessly through the human digestive track. This resulted in 3 fragment classes: 5-7 mm, 7-9 mm and > 9 mm. Blade speed of the kitchen blender was reduced to 9100 rpm, using a Variac, as before, to prevent break up of the more fragile fragments. As before, blender blades were deliberately dulled by grinding to a 2.5 mm flat width. Blending times of 40 s were found adequate. The fixed slit size sieve, used previously, was modified to allow adjustment of the slit width. Sieve slit openings with a length of 400 mm and widths from 1.0 to 2.5 mm were tested. A sieve slit opening width of 1.5 mm was found optimal for the fragments produced.

A total of 50 tests were run, using drained, canned RTPs. All tests were carried out by adding 10 dyed pits and 20 dyed fragments (10 7-9mm and 10 >9mm) to 567g of cherry stock to which 355 g (3/4 pint) water had been added. The mixture was then blended and the resultant slurry passed through the slit sieve. The slurry was stirred for 83 ± 24 s to pass the slurry through the sieve. All passed material was caught on a screen (with openings of 1.7×1.3 mm) fine enough to trap all fragments 3 mm or longer. Substantially all cherry stock and skins passed through the sieve by this procedure. The pits and fragments in the sieve were characterized by length and reported as "detected". Pits and fragments on the screen were reported as "not-detected".

A limited number (6) of 5-1 cherry batches of 567 g each were run as well, but because a limited supply, no definitive data could be obtained. However, results seemed similar to those reported below.

RESULTS AND DISCUSSION

Of the fifty trials of the canned cherry stock which were run, 33 came from an early shipment, 17 from a later one. All of the added pits were detected, none were fragmented. The first and second shipment averaged 0.24 natural pits/567 g, and 1.53 natural pits/567 g batch, respectively. On the basis of an exact chi-square test, and using >100 cherries/567 g (Haff and Schatzki 1994), one obtains $\chi^2 = 25.6$, $df=1$, hence the shipments were different at the $p>0.0005$ level. It appears the latter shipment consisted of high-pit reject product. Except for the natural pit frequency, the two shipments did not differ significantly in any of the other results.

Of the 500 >9 mm fragments which had been added (10 per trial), 485 were recovered ("detected" + "not-detected", but not including natural fragments) in the sieve or screen, suggesting that 15 fragments broke into smaller ones (Table 1). Added fragments commonly consisted of hollow half-spheres, which are easily broken into smaller parts (Fig. 1). In two tests 11 fragments were actually recovered, possibly because of an error in size measurement. Ignoring the latter, 15/500 or 3% of the added fragments were fragmented further. The detection rate amounted to 7.7 ± 1.4 fragments per trial or 0.79 based on the 485 fragments presented to the sieve. For the 7-9 mm fragments 528 were recovered, the additional ones presumably arising from the broken >9 mm half-spheres. The detection rate was 8.31 ± 1.8 fragments per trial or again 0.79 based on the presented fragments. Only six 5-7 mm dyed fragments were recovered of which two were detected. None had been added.

TABLE 1.
PIT & FRAGMENT RECOVERY IN 50 TESTS

	Fragment Length		
	7-9 mm	>9 mm	Pits
Added (10 per test)	500	500	500
Detected (in-sieve) ^a	417	385	500
Not-Detected (on screen) ^a	111	100	0

^a added fragments only, number does not include natural fragments or pits

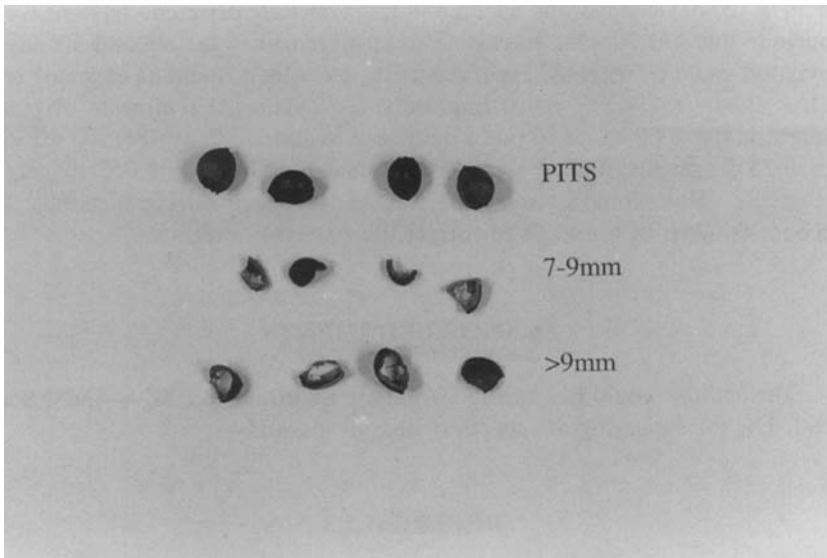


FIG. 1. RED TART CHERRY PITS AND PIT FRAGMENTS, DYED TO AID DETECTION

All of the 34 natural (nonadded) pits were detected as well. In addition, 8 natural (nondyed) fragments were observed, of which 7 were detected. Five of these measured 7-9 mm, three were greater than >9 mm. There was, of course, no way to determine whether the former had been present in the original shipment or resulted from fragmentation of larger natural fragments.

The detection rate for the two major fragment lengths are surprisingly close. This can be understood on the basis of fragment geometry. Nondetected fragments tend to slip through the sieve "side-on", thus the governing dimension is the radius of curvature, i.e. the radius of the pits, which is relatively uniform. The fragment length should thus be of minor importance. The detection rate for the natural fragments was similar, 7 out of 8.

Since the ten added fragments pass (or do not pass) the slit independently of each other, the recovery rate can be viewed as the average of ten independent experiments with a mean of $7.9/10=0.79$ and a standard deviation of $0.15 \times (10-1)^{0.5}=0.45$ or $0.13 \times (10-1)^{0.5}=0.39$. But a single fragment experiment is just a classical binomial experiment for which the standard deviation is expected to be $(p \times (1-p) / n)^{0.5}$. Here $p=0.79$ and $n=1$, which results in a calculated standard deviation of 0.41, which is just what was obtained. The same expressions apply to a test of a commercial lot. Suppose 100 tests are conducted

on 567 g (20 oz) samples and a total of 4 fragments are detected. The one would conclude that $4/0.79=5.1$ fragments were presented to the slit and a standard deviation could be obtained experimentally, but which would be expected to be $5.1 \times 0.41 / (5.1-1)^{0.5} = 1.0$ fragments. To obtain the fragments originally present in the 2000 oz tested one would need to divide 5.1 by $485/500=0.97$ to get 5.25 fragments if they were $>9\text{mm}$ and by $528/500=1.055$ to get 4.8 fragments. This would account for fragments broken during blending. (No account is taken of breakage to correct the standard deviations.)

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